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STATIC STABILITY WIND-TUNNEL TEST OF 18,  
22, AND 26 CALIBER CYLINDER-OGIVE BODIES  
AND AN AEROBALLISTIC TEST VEHICLE AT  
MACH NUMBERS FROM 0.69 TO 4.24

Harvey Chaplin

Naval Ordnance Laboratory  
White Oak, Maryland

28 July 1953

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**NAVORD REPORT**

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STATIC STABILITY WIND-TUNNEL TEST OF 18, 22, AND 26  
CALIBER CYLINDER-OGIVE BODIES AND AN AEROBALLISTIC  
TEST VEHICLE AT MACH NUMBERS FROM 0.69 TO 4.24

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NAVORD



**U. S. NAVAL ORDNANCE LABORATORY**  
**WHITE OAK, MARYLAND**

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**Aeroballistic Research Report 186**

**STATIC STABILITY WIND-TUNNEL TEST OF 18, 22, AND 26  
CALIBER CYLINDER-OGIVE BODIES AND AN AEROBALLISTIC  
TEST VEHICLE AT MACH NUMBERS FROM 0.69 TO 4.24**

**Prepared by:**

**Harvey Chaplin**

**ABSTRACT:** This report presents the results of an investigation in the 40 x 40 Cal Aeroballistics Tunnel No. 1 to determine the static stability of the Naval Ordnance Test Cylinder/Ogive Bodies and an Aeroballistic Test Vehicle at Mach numbers from 0.69 to 4.24.

**U. S. NAVAL ORDNANCE LABORATORY**  
**PORTLAND, OREGON**

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NAVED Report 2934

28 July 1953

This investigation was performed at the request (reference a) of the U. S. Naval Ordnance Test Station. The wind-tunnel data were obtained 21 and 22 May 1953. The investigation was performed under task number NOL-4034-453-1-53.

The purpose of this investigation was to determine the static stability of the Naval Ordnance Test Station Long Bodies and an Aeroballistic Test Vehicle.

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STATIC STABILITY WIND-TUNNEL TEST OF 18, 22, AND 26  
CALIBER CYLINDER-OJIVE BODIES AND AN AEROBALLISTIC  
TEST VEHICLE AT MACH NUMBERS FROM 0.69 TO 4.24

INTRODUCTION

1. The trend of rocket design toward longer bodies has made it necessary to obtain design data on bodies up to 26 calibers in length. In this investigation static stability data were obtained for 18, 22, and 26 caliber bodies as a part of the Naval Ordnance Test Station Systematic Wind-Tunnel Test Program. Results previously obtained under this program for 10, 14, and 18 caliber bodies are reported in references (b) through (g).

2. This report presents pitching moment and normal force data obtained for the Naval Ordnance Test Station Long Bodies at Mach numbers of 0.585, 0.92, 1.56, 1.86, 2.87, and 4.24 and for an Aeroballistic Test Vehicle at Mach numbers of 0.58, 0.92, 1.56, and 2.17.

4. All data were obtained using a five-component internal strain-gage balance (designated 5-5) designed and built at the Naval Ordnance Laboratory. The angles of attack include a correction for elastic deflection of the balance.

#### RESULTS

5. The data are plotted in coefficient form versus angle of attack in Figures 3 through 9. No analysis of these data is being made in this report.

6. Tabulated data of this test are also presented. The sheets of data are in order of run number and have lists of corrected angle of attack, normal force coefficient, and pitching moment coefficient.



REFERENCES

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- (b) DeMeritte, F. J., Aeroballistic Research Investigation of a Family of Rectangular Pinned Models at Mach Number 2.92 NOLM 10117 (Restr) (1949)
- (c) DeMeritte, F. J. and Greene, John E., Aeroballistic Research Investigation of Body and Rectangular Fin Combinations at Mach Numbers 1.86 and 1.96 NOLM 10122 (Restr) (1949)
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- (e) Darling, J. A. and DeMeritte, F. J., Aeroballistic Research Investigation of NUTS Boshels Navord Report 1946 (Conf) (1950)
- (f) DeMeritte, F. J., Highberg, I., and Darling, J., Aeroballistic Investigation of the NUTS Boshels at Mach Number 1.86 and 2.92 Navord Report 1946 (Conf) (1950)
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TABLE I

LIST OF RUNS AND TEST RECONDUS CONDITIONS

Run	Configuration	Reynolds No.	Dynamic Pressure (psi)	Reynolds No. (per ft.)	Figure
1	126	0.885	3.41	$3.91 \times 10^6$	3
2	122	—	—	—	—
3	128	—	—	—	—
4	126	0.974	4.87	4.50	4
5	122	—	—	—	—
6	128	0.883	—	—	—
7	126	1.07	5.50	4.87	6
8	122	—	—	—	—
9	128	—	—	—	—
10	126	—	—	—	—
11	122	—	—	—	—
12	128	—	—	—	—
13	126	—	2.89	2.85	7
14	122	—	—	—	—
15	128	—	—	—	—
16	126	—	—	—	—
17	122	—	0.887	1.39	8
18	128	—	0.888	—	—
19	126	—	0.888	—	—
20	122	—	0.888	—	—
21	128	—	0.888	—	—
22	126	—	0.888	—	—
23	122	—	0.888	—	—
24	128	—	0.888	—	—
25	126	—	0.888	—	—
26	122	—	0.888	—	—
27	128	—	0.888	—	—
28	126	—	0.888	—	—
29	122	—	0.888	—	—
30	128	—	0.888	—	—
31	126	—	0.888	—	—
32	122	—	0.888	—	—
33	128	—	0.888	—	—
34	126	—	0.888	—	—
35	122	—	0.888	—	—
36	128	—	0.888	—	—
37	126	—	0.888	—	—
38	122	—	0.888	—	—
39	128	—	0.888	—	—
40	126	—	0.888	—	—
41	122	—	0.888	—	—
42	128	—	0.888	—	—
43	126	—	0.888	—	—
44	122	—	0.888	—	—
45	128	—	0.888	—	—
46	126	—	0.888	—	—
47	122	—	0.888	—	—
48	128	—	0.888	—	—
49	126	—	0.888	—	—
50	122	—	0.888	—	—
51	128	—	0.888	—	—
52	126	—	0.888	—	—
53	122	—	0.888	—	—
54	128	—	0.888	—	—
55	126	—	0.888	—	—
56	122	—	0.888	—	—
57	128	—	0.888	—	—
58	126	—	0.888	—	—
59	122	—	0.888	—	—
60	128	—	0.888	—	—
61	126	—	0.888	—	—
62	122	—	0.888	—	—
63	128	—	0.888	—	—
64	126	—	0.888	—	—
65	122	—	0.888	—	—
66	128	—	0.888	—	—
67	126	—	0.888	—	—
68	122	—	0.888	—	—
69	128	—	0.888	—	—
70	126	—	0.888	—	—
71	122	—	0.888	—	—
72	128	—	0.888	—	—
73	126	—	0.888	—	—
74	122	—	0.888	—	—
75	128	—	0.888	—	—
76	126	—	0.888	—	—
77	122	—	0.888	—	—
78	128	—	0.888	—	—
79	126	—	0.888	—	—
80	122	—	0.888	—	—
81	128	—	0.888	—	—
82	126	—	0.888	—	—
83	122	—	0.888	—	—
84	128	—	0.888	—	—
85	126	—	0.888	—	—
86	122	—	0.888	—	—
87	128	—	0.888	—	—
88	126	—	0.888	—	—
89	122	—	0.888	—	—
90	128	—	0.888	—	—
91	126	—	0.888	—	—
92	122	—	0.888	—	—
93	128	—	0.888	—	—
94	126	—	0.888	—	—
95	122	—	0.888	—	—
96	128	—	0.888	—	—
97	126	—	0.888	—	—
98	122	—	0.888	—	—
99	128	—	0.888	—	—
100	126	—	0.888	—	—

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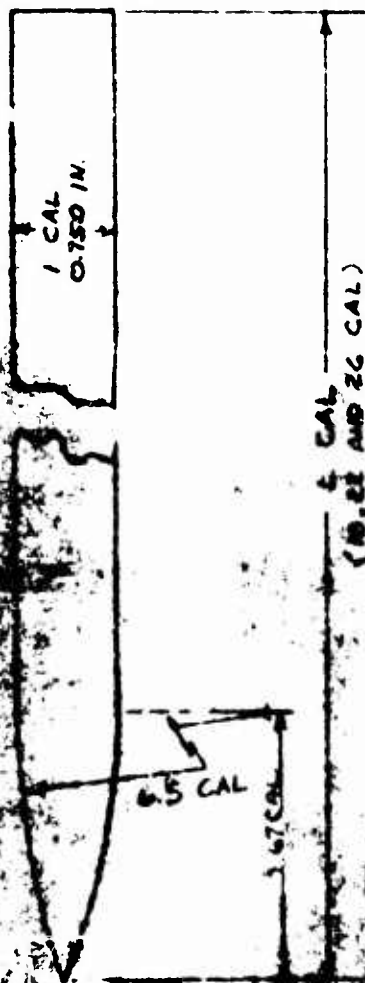


FIGURE 1  
NOTS LONG BODIES

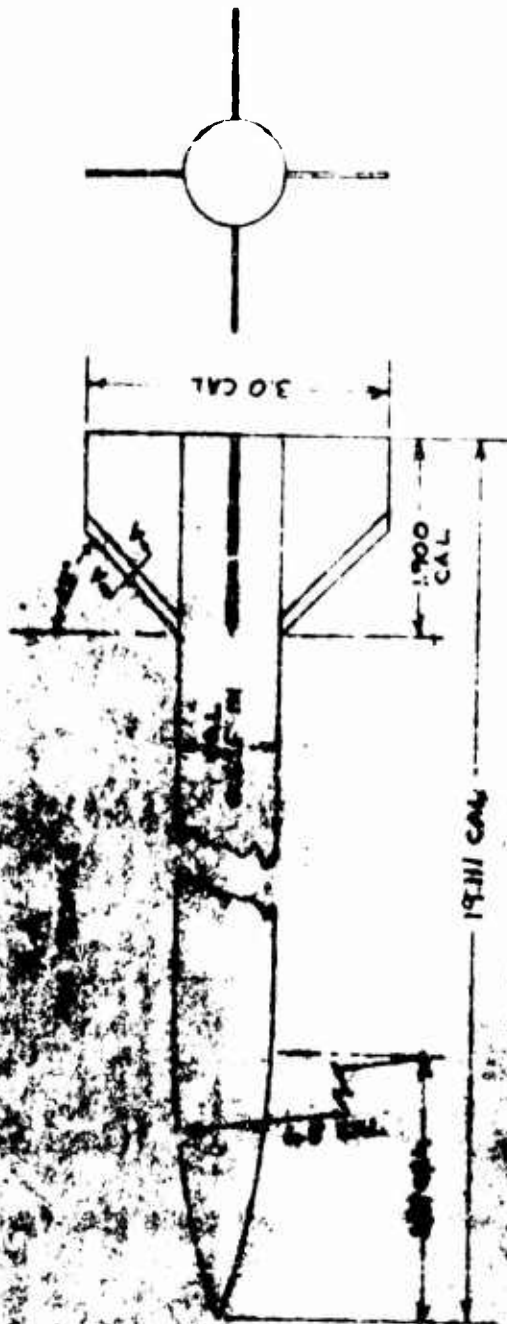
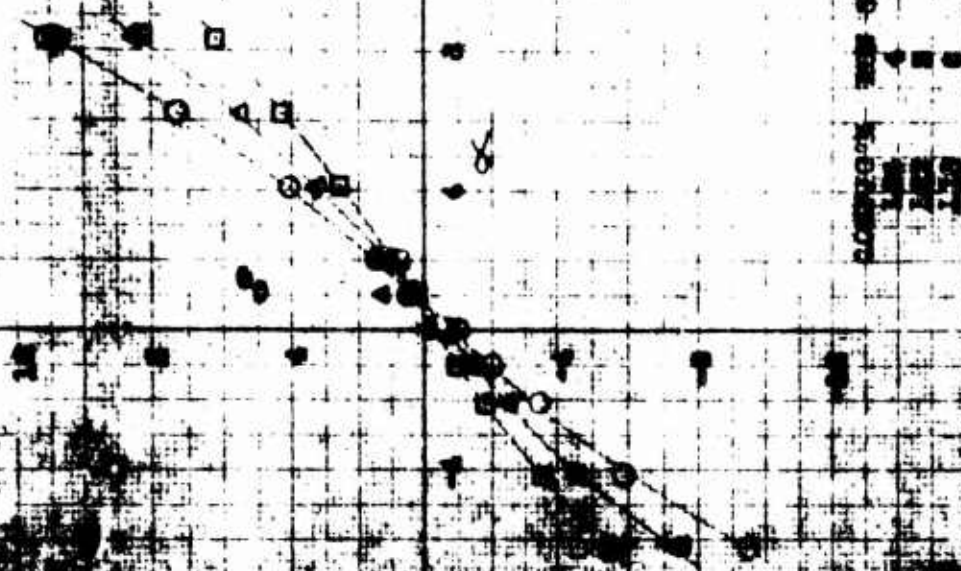


FIGURE 2  
ATV  
BALLISTIC TEST VEHICLE

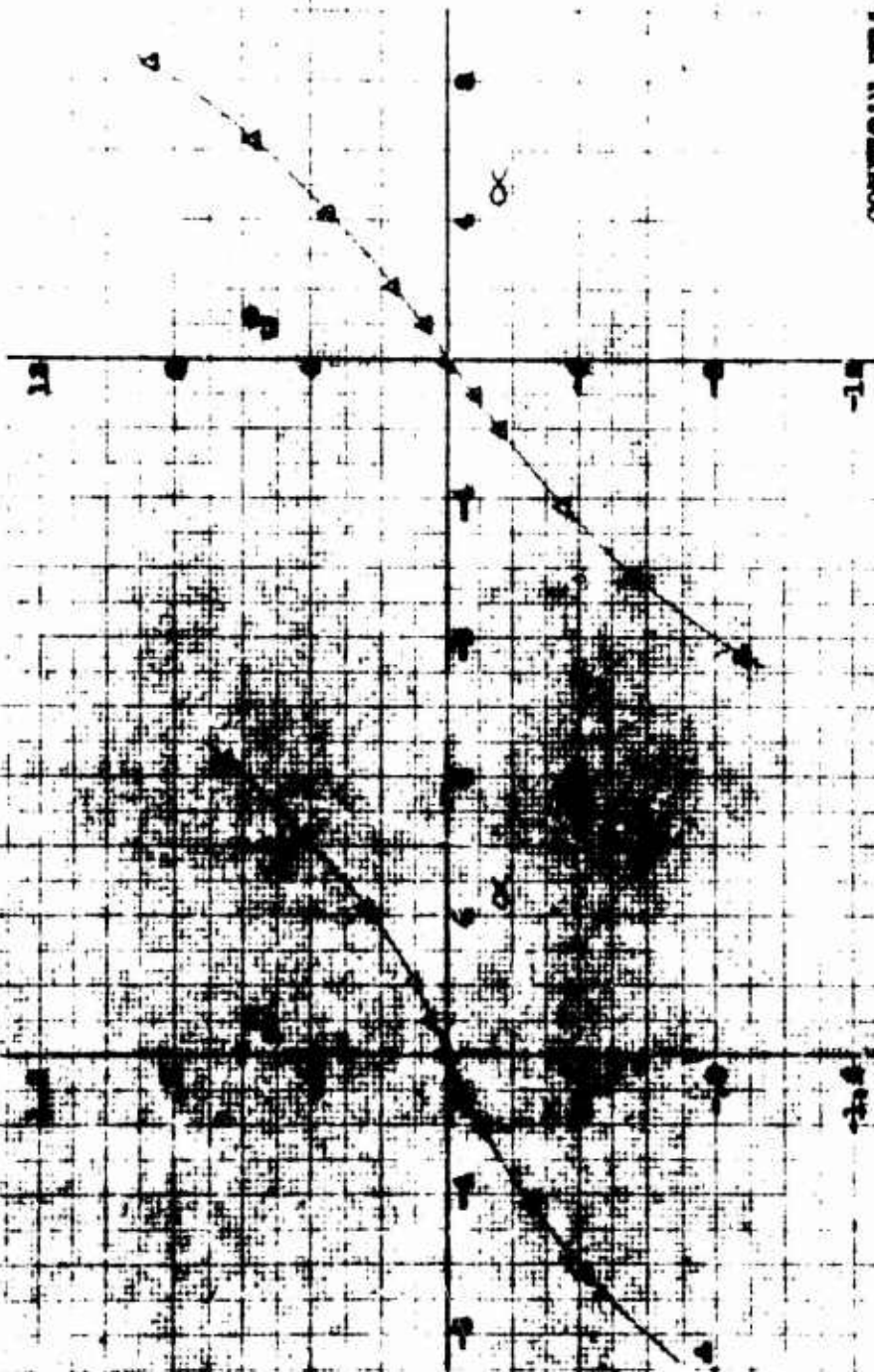
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COMPTON H. H. STREIBER  
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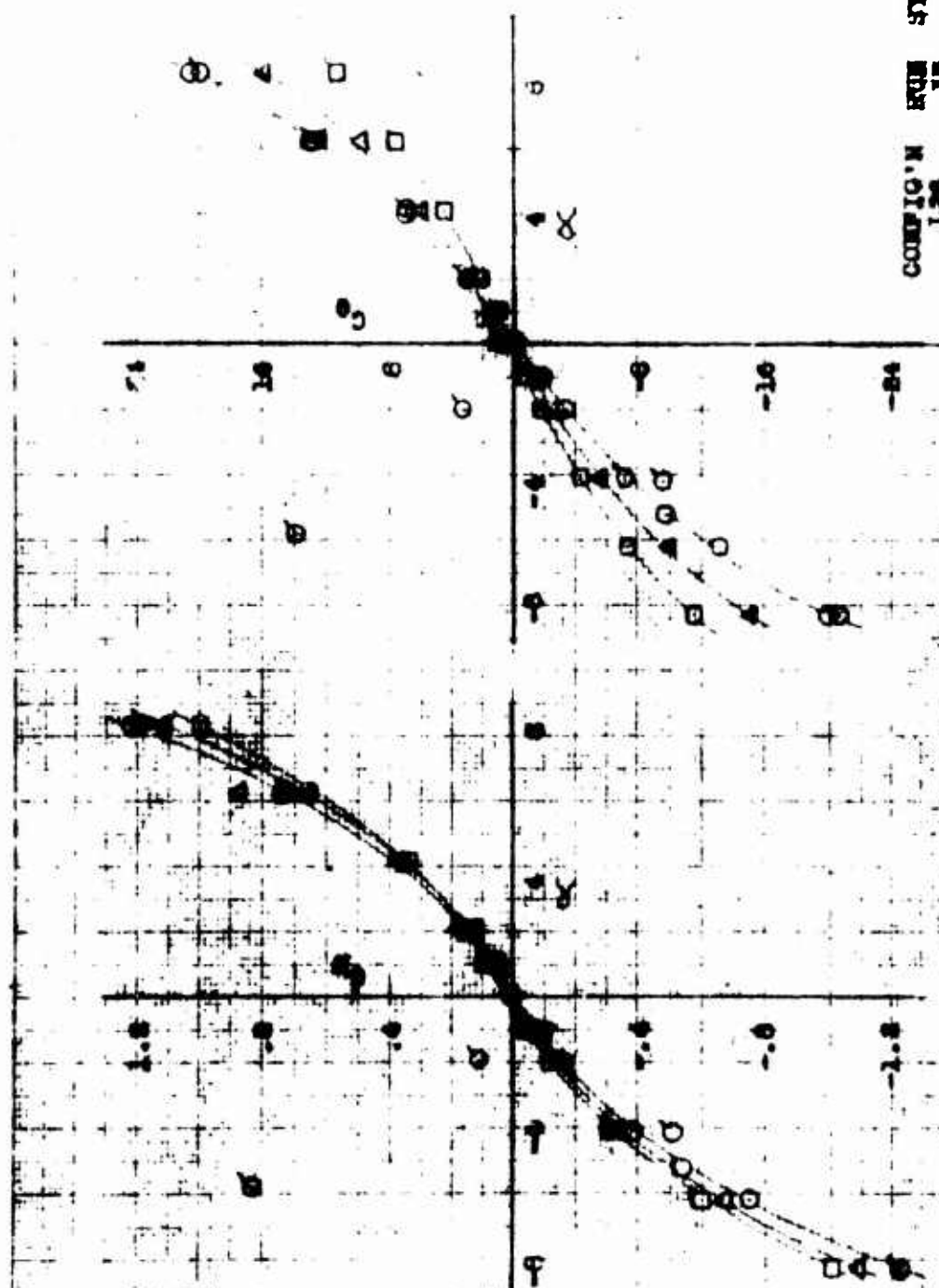


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COMPIO'N  
L26  
L26T  
L22  
L18

RUN  
13  
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SYMBOL  
○ ○ ◐ ◑



1.26  
1.26T  
1.22  
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1.26  
1.26T  
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# NAVORD REPORT 2034

COMPTON	WAVE	SYMBOL
1.5	1.5	○
1.5	1.5	△
1.5	1.5	□

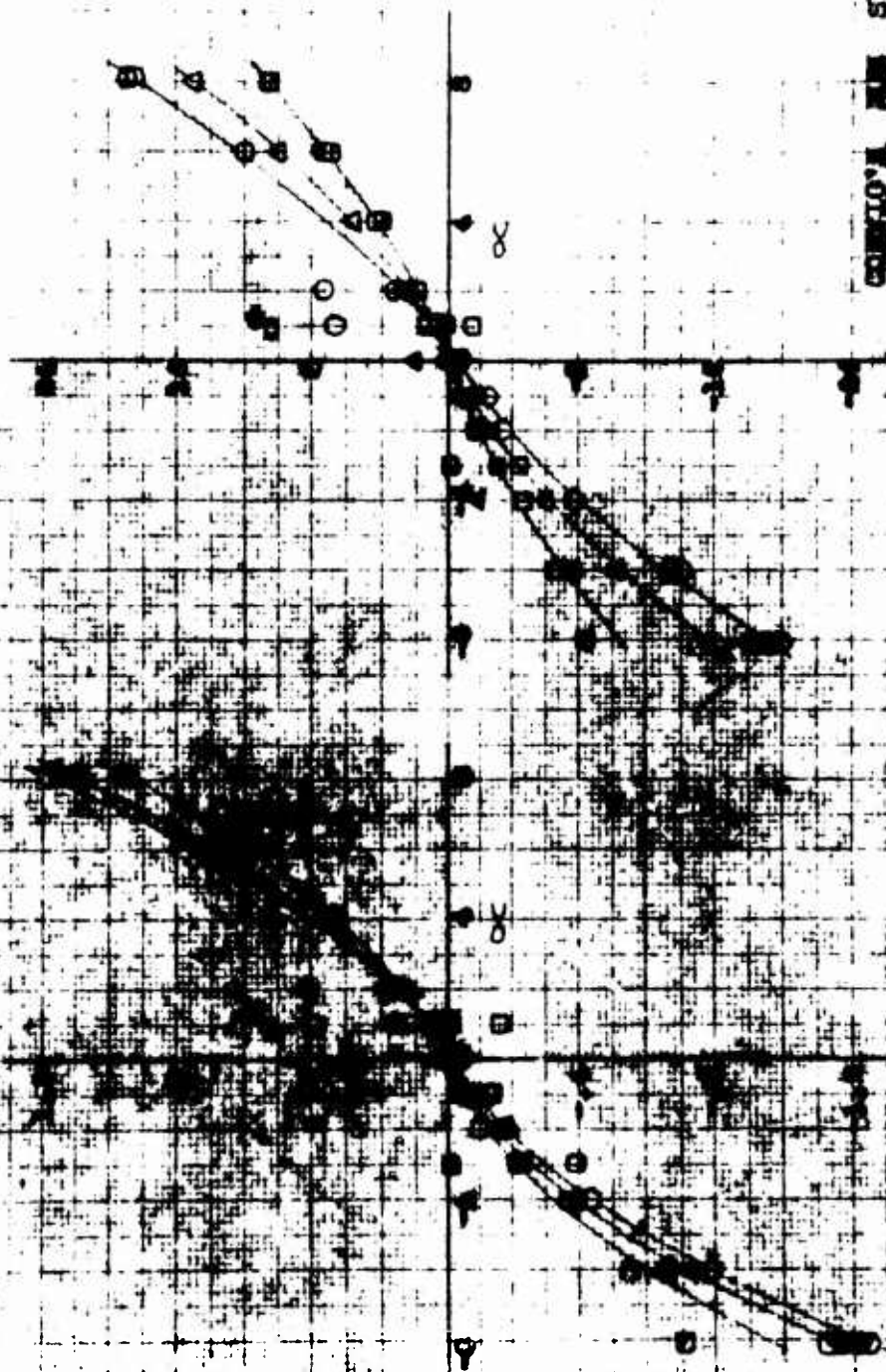
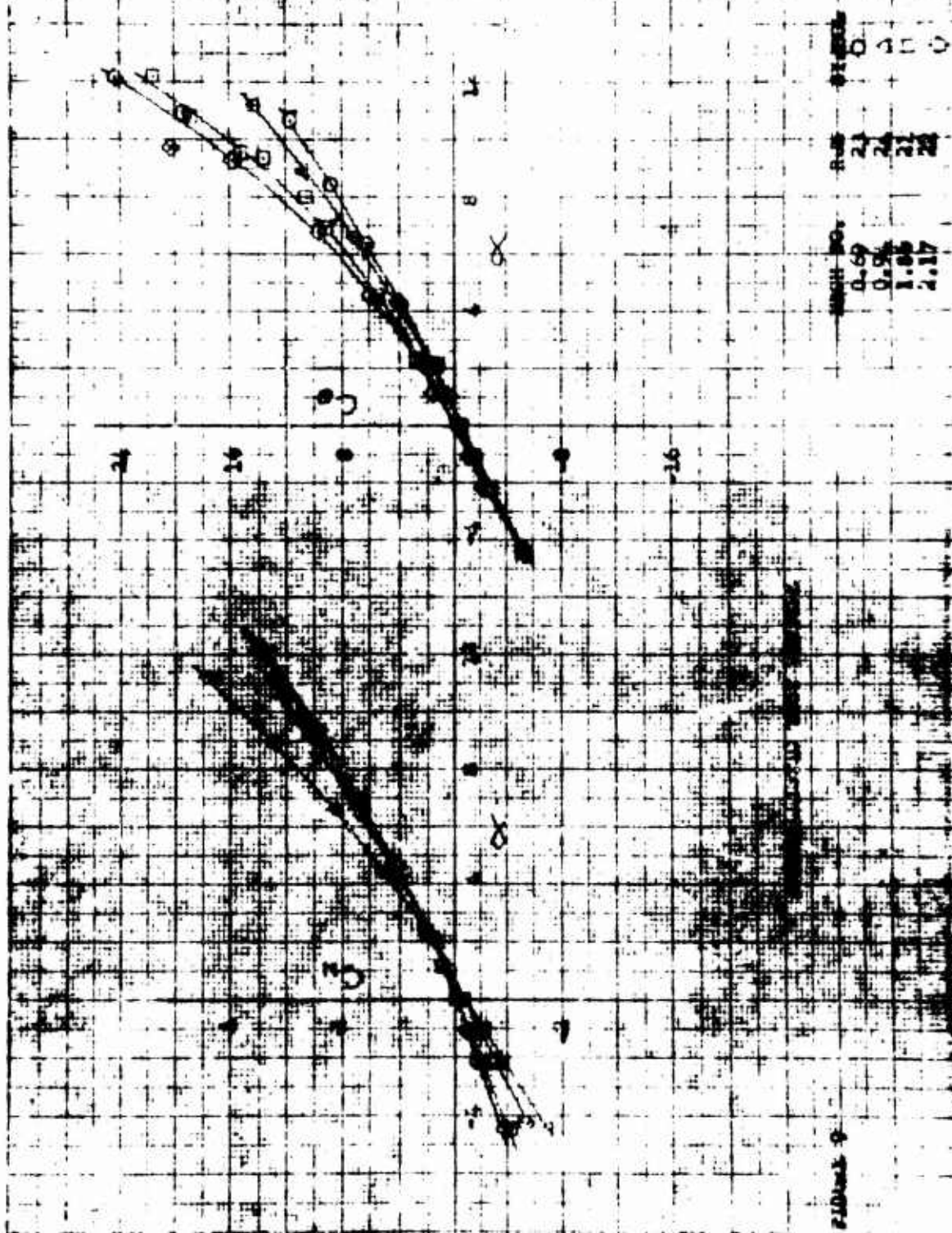


Figure 1

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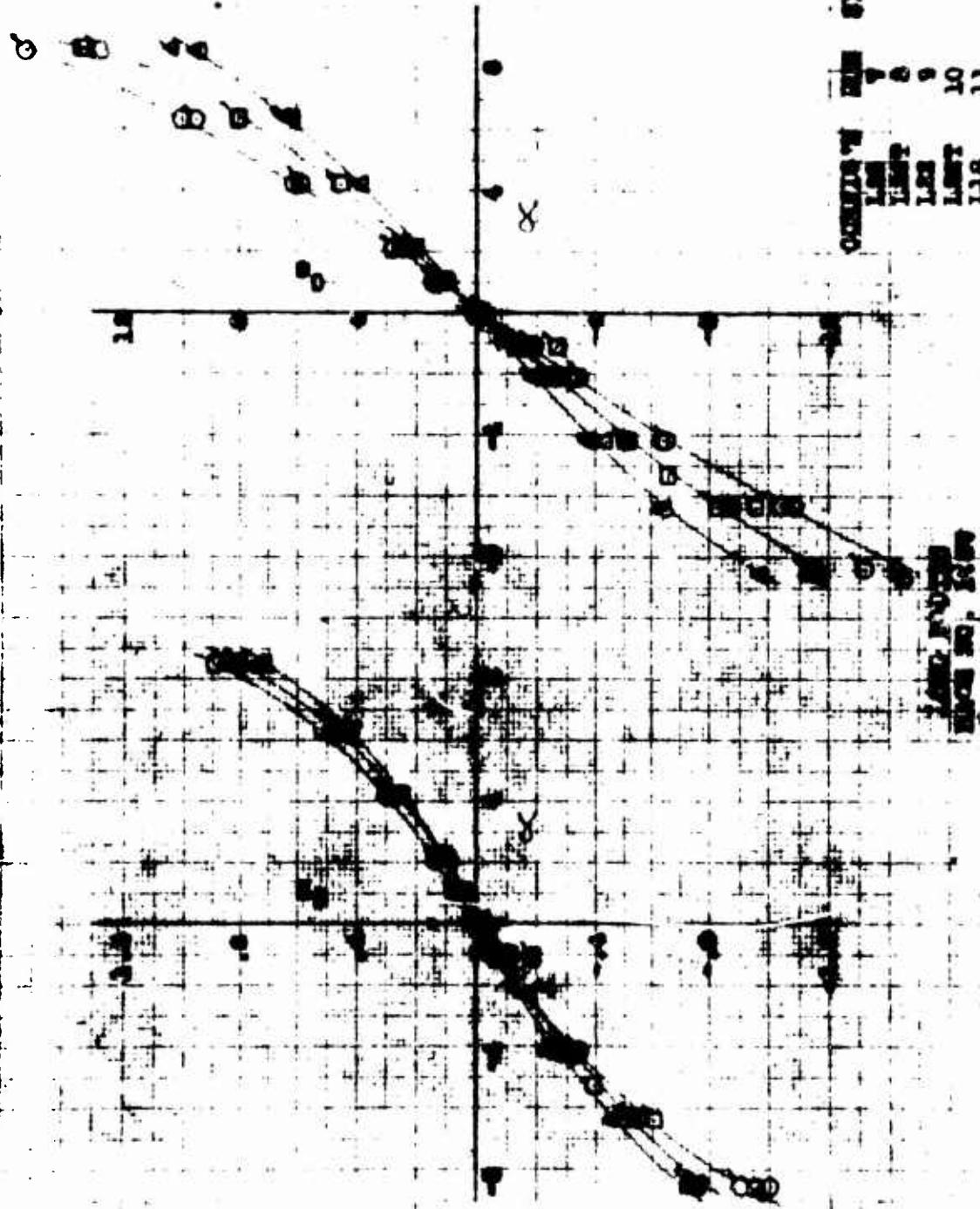
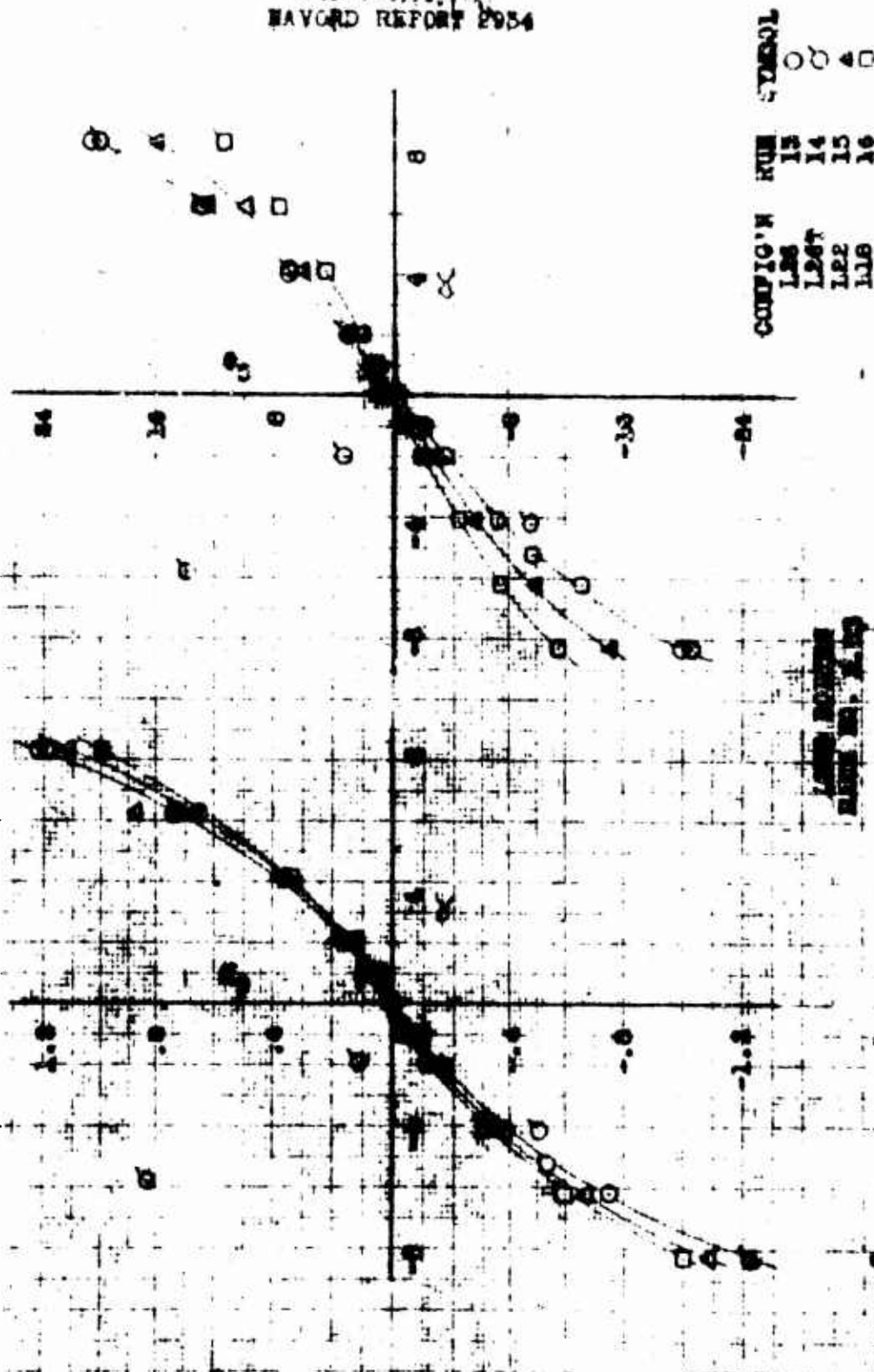


FIGURE 1

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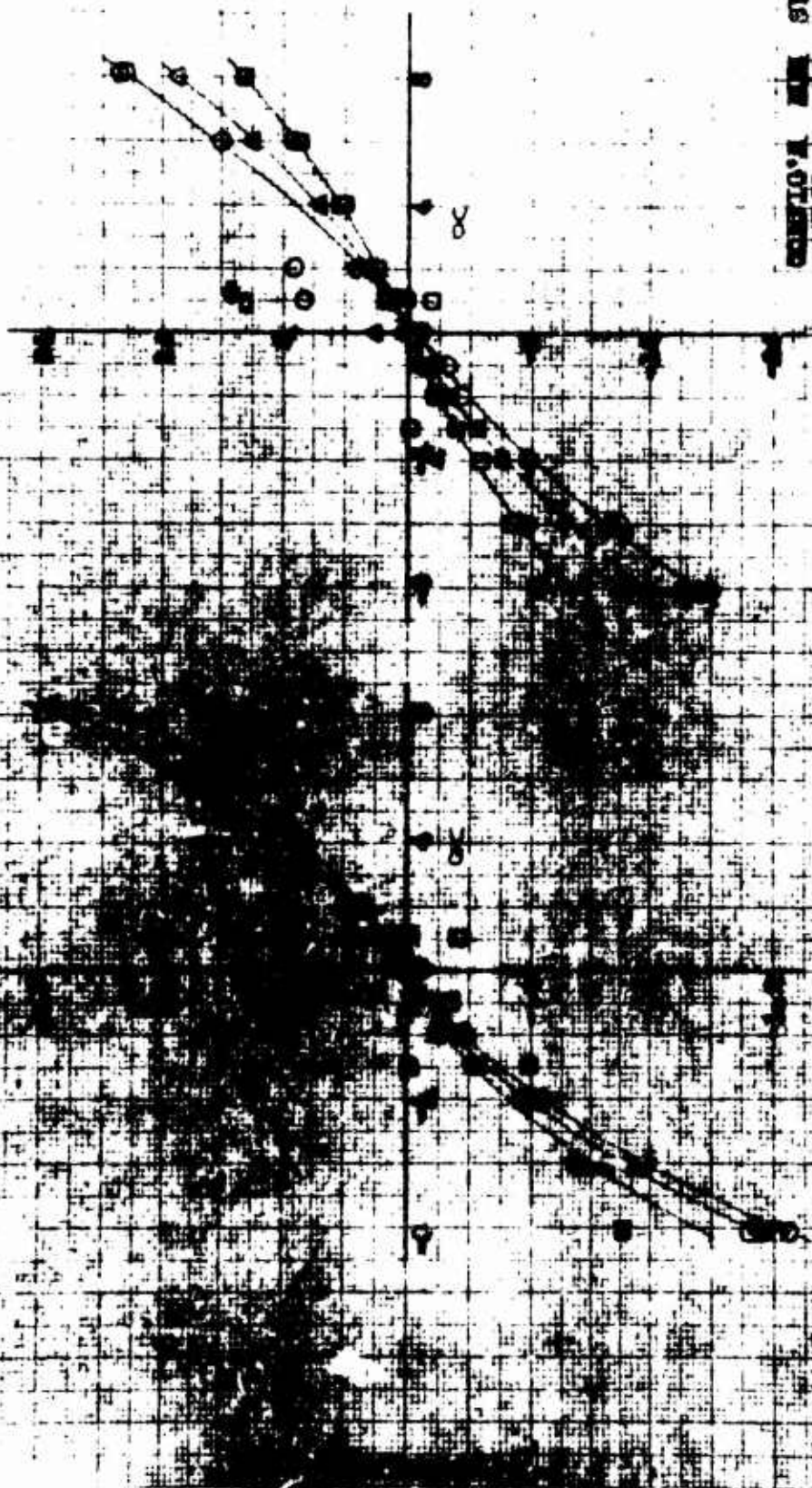


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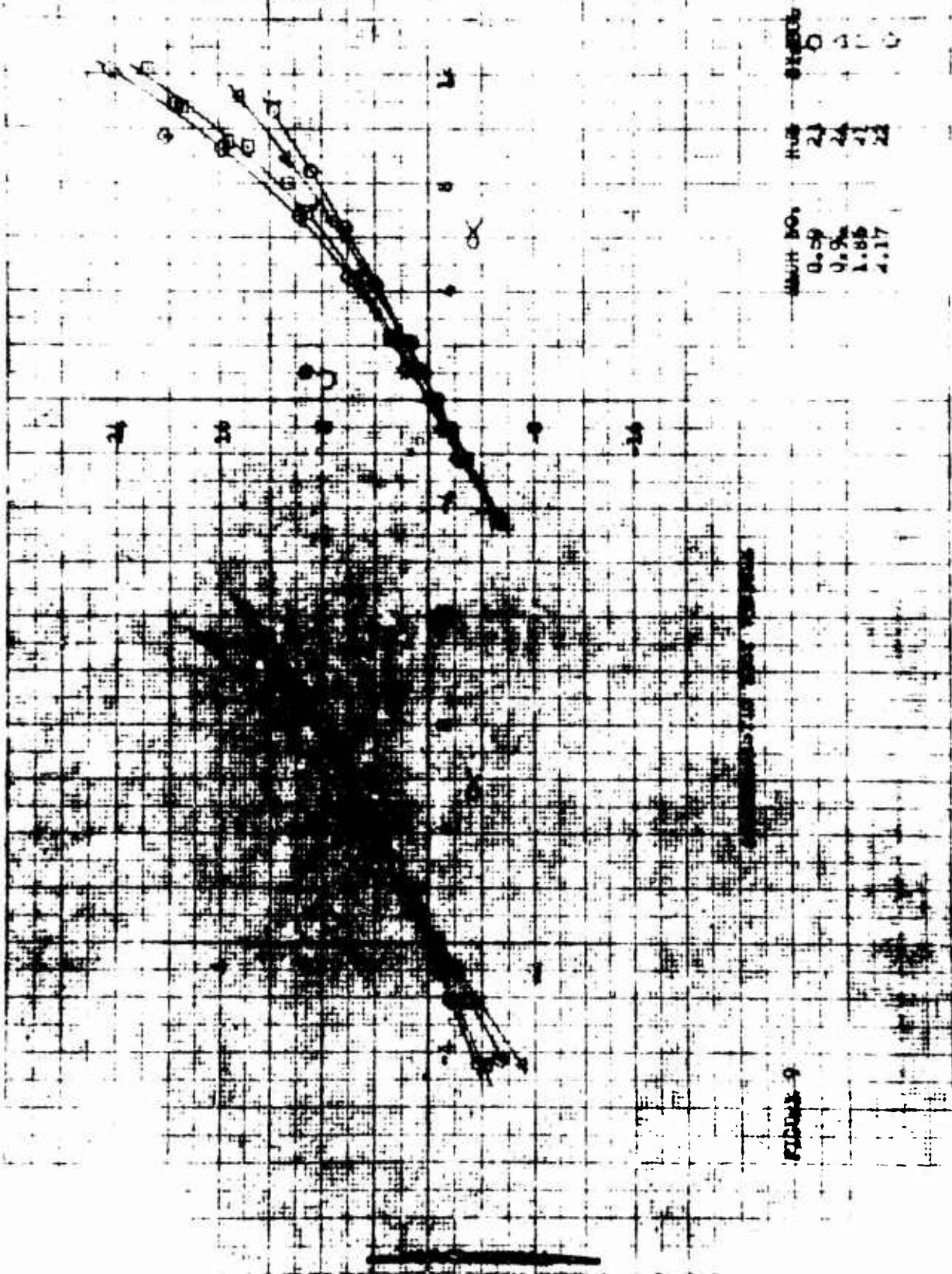
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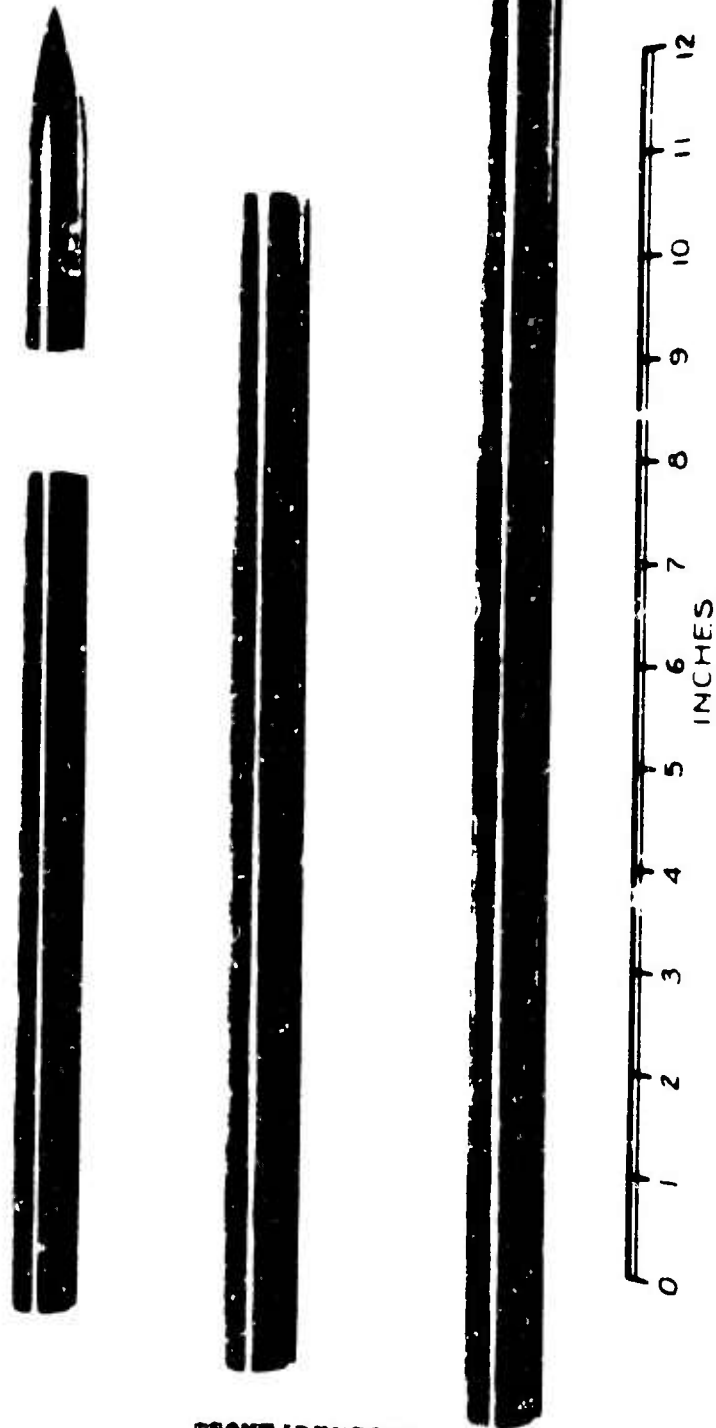


Fig. 10



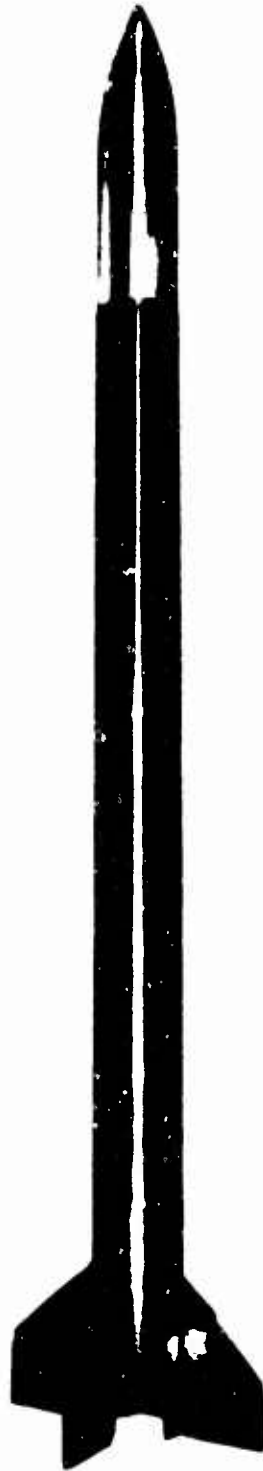


Fig. 11

Tabulated Data Information

- A. Column Heading symbols are defined on page 1.
- B. Decimal points for the coefficients and angles occur as indicated on Run 1.
- C. The sign of the coefficient and angles follow the readings.

224 01

	Cl	CN	Co
6	16-	5444-	9 2757-
4	11-	3565-	6 1661-
2	06-	1747-	3 1107-
1	04-	1367-	2 3674-
	02-	0545-	9 347-
	00-	0219-	1652-
2	06-	0870-	1 7402-
4	07-	2142-	3 9093-
6	12-	3708-	6 6958-
8	18-	5491-	9 7071-
2	06-	1714-	3 1131-
2	03-	0804-	1 6269-
1	03-	0874-	1 5729-
	02-	0712-	1 1224-
1	01-	0147-	3505-
1	03-	0972-	1 7907-

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**228 03**

	<b>CL</b>	<b>CN</b>	<b>CO</b>
5	17-	4774-	6 9430-
4	11-	3085-	4 5584-
2	06-	1440-	2 6032-
1	04-	1199-	1 7 37-
	01-	0528-	6 143-
1	01	0026-	1 143
2	03	0677	1 2122
4	08	1423	3 0547
6	13	3209	5 1229
8	20	5207	7 0897
6	17-	4667-	6 8432-
2	06-	1432-	2 6209-
1	04-	1785-	1 5159-
1	00	0169-	0 120
1	04-	1225-	1 6022-

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228 03

$\alpha$	CN	Co
6 18-	4296-	5 1968-
4 12-	2627-	3 4054-
2 06-	1305-	1 8272-
1 04-	1157-	1 2974-
02-	0422-	5 5510-
1 00	0118-	0701
2 03	0355	7213
4 08	1624	3 3062
6 14	2819	3 8842
8 20	4569	5 8180
2 07-	1590-	1 9290-
1 04-	1117-	1 2535-
1 01	0003-	1579
6 18-	4387-	5 2616-

228 04

	OL	CN	Co
6	23-	5602-	9 5187-
4	15-	3469-	5 9111-
2	08-	2034-	3 4036-
1	05-	1172-	1 9924-
	01-	0407-	6 463-
1	01	0044	2 211
2	04	0738	1 4646
4	11	2247	4 0340
6	19	4154	7 3354
8	27	6591	11 1490
	02-	0640-	1 0109-
1	05-	1219-	2 0307-
1	01	0163	4 092
8	27	6487	10 9616
8	27	6364	10 8319

22A 05

A		CN		C	
6	25-	5	409-	7	5001-
4	14-	3	14-	4	5422-
2	08-	1	771-	2	4901-
1	05-	1	200-	1	5464-
	02-		0501-		5734-
1	04		0773	1	2714
2	04		0564	1	1055
4	12		2103	3	2477
6	20		3680	5	5621
8	30		0201	H	5184
1	05-		1103-	1	4354-
1	01		0001		2054
2	05		0703	1	3337
6	25-		5214-	7	2773-



22A 06

α

6	27-
4	1M-
2	09-
1	05-
	01-
1	02
2	04
4	13
6	21
8	31
1	05-
1	01
2	06
8	40

αN

4753-
3141-
1524-
0912-
0302-
0100
0258
1910
3285
5129
0M44-
0072
0776
6761

Co

5	492-
3	0451-
1	7799-
1	0794-
	2769-
	3162
	7124
2	5840
4	2827
6	2175
1	0061-
	2605
1	1142
8	1964

228 07

	$\alpha$	CN	C <sub>0</sub>
8	45 -	7564 -	14 3079 -
6	34 -	5524 -	10 8256 -
4	21 -	3404 -	6 5723 -
2	11 -	1407 -	3 1751 -
1	07 -	0869 -	1 5990 -
	01 -	0114 -	2 281 -
1	05	0610	1 3152
2	09	1164	2 5334
4	19	2950	5 7909
6	33	5120	10 0456
8	51	8874	16 4721
5	36 -	5559 -	10 8744 -
1	07 -	0708 -	1 7175 -
8	86 -	0166 -	14 4314 -
4	21 -	3308 -	6 4582 -
4	20	3023	5 9596

28A 06

$\alpha$	CN	C0
8 49-	4052-	16 3943-
6 34-	5367-	10 4263-
4 21-	3418-	6 5509-
2 14-	1713-	3 4561-
1 07-	0839-	1 8179-
01-	0107-	2400-
1 05	0604	1 3523
2 10	1277	2 7417
4 19	2286	5 8257
6 31	4828	9 5138
8 47	8149	15 0980
8 40-	7290-	13 2396-
1 07-	0806-	1 8766-

**NAVJAG Report 2934**

**BUN**  
24A 04

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8	59-
6	37
4	22
2	11
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CN

9554-
5309-
3205-
1634-
0940-
0203-
0432
1009
2554
4641
8509
8425
3967-
0903-

Ce

14	5137-
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5	2008-
2	6890-
1	4979-
	1634-
1	0501
2	1531
4	8498
7	9532
13	3003
13	2917
6	6106-
1	4840-

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22A 10

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4	34
8	52
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6	40-
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CN

7	313-
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3	161-
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0	955-
0	167-
0	530
1	151
2	569
4	700
8	167
7	535-
6	079-
1	844-
5	005-

C

1	1	3	6	7	3-
	8	2	2	1	9-
	5	0	6	2	4-
	2	5	8	5	4-
	1	4	9	2	1-
		0	5	2	8-
	1	1	9	7	8
	2	2	9	2	0
	4	5	8	8	8
	7	9	7	2	9
1	2	7	0	2	8
1	1	6	0	8	4-
	9	5	8	4	2-
	2	7	3	5	4-
	8	1	9	6	2-

REPORT 8934

22A 11

	$\alpha$	CN	C0
8	66-	9585-	11 7178-
6	37-	4776-	6 5309-
4	22-	2740-	3 8728-
2	11-	1347-	1 9058-
1	06-	0742-	1 0334-
	00	0078-	0083
1	06	0529	9944
2	11	1138	1 9392
4	22	2498	3 8054
6	37	4476	6 3930
8	58	8050	10 3408
1	06-	0722-	1 0070-
6	36	4399	6 3337

**MAVED Report 8934**

**22H 12**

$\alpha$	CN	C
35-	4464-	6 2242-
25-	3361-	4 4082-
11-	1394-	1 9679-
06-	0824-	1 1012-
00	0037-	0 459
1 06	0580	1 0339
2 11	1220	1 9656
1 22	2604	3 8465
6 35	4174	6 0964
8 54	7313	9 5580
8 55-	7473-	9 6791-
4 22-	2756-	3 8231-
1 06-	0810-	1 0682-
1 06	0616	1 0458
8 53	7133	9 4089



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22A 13

$\alpha$	CN	C
6 20-	7521-	13 1884-
4 12-	3850-	7 3403-
2 06-	1652-	3 3600-
1 03-	0796-	1 6112-
00	0014	0204-
1 03	0760	1 8338
2 06	1845	3 1491
6 20	7396	12 9438
8 29	1 2237	20 4752
8 29-	1 2327-	20 5917-
5 16-	8431-	9 8359-
1 03-	0800-	1 7603-
1 03	0612	1 3489
4 12	3612	6 9828

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26A 14

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5	80-
4	16-
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1	205A-
	8270
	5149-
	1616
	0756-
	0044
	0711
	1492
	3661
	7359
1	1835
	379A-

Ce

20	0555-
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9	5996-
3	3052
1	5594-
	0856
1	5286
3	011A
7	0054
12	8511
19	7516
7	2406-

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 REPORT Report 1994

22A 15

$\alpha$	CN	Ce
8 31-	1 0434-	15 2045-
6 21-	6753-	9 9550-
4 13-	3385-	5 5811-
2 06-	1391-	2 4500-
1 03-	0728-	1 2287-
1 03	0573	1 1917
2 07	1793	2 9494
4 13	3774	6 0089
6 26	8760	12 6434
8 32	1 1230	15 7796
00	0144	1701
1 03-	0693-	1 1911-
6 21	6725	9 9248
1 03	0622	1 2209
2 06	1230	2 3479

RA/CHD Report 8954

220 16

	$\alpha$	CN	Co
8	33-	1 0029-	11 4007-
6	22-	6134-	7 4247-
4	13-	3215-	4 3411-
2	06-	1261-	1 9497-
1	03-	0450-	0420-
	00	0021-	0621-
1	04	0916	1 1045
2	07	1422	2 1307
4	13	3305	4 4700
6	22	6633	7 6010
8	33	9852	11 3133
6	22	6305	7 5362
1	03-	0667-	9952-
1	03	0613	9702
2	06	1404	2 1150
1	03	0883	1 1640

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 RAVEN Report 8934

22A 17

	0.	CN	Co
8 04-	1	1237-	12 2076-
6 06-		7863-	13 3209-
4 04-		4306-	7 7221-
2 04-		1241-	3 4046-
1 01-		0732-	1 5343-
00		0245-	3 6649-
1 03		3222	6 6222
2 03		4062	7 2042
6 05		7100	11 9704
8 06	1	1242	12 0703
1 01-		1309-	2 3122-
01-		0475-	0702-
1 00		0317	7220
2 02		1737	3 7242
8 08-	1	2463-	19 2212-
8 08-	1	2132-	19 3212-
6 06-		2423-	14 1222-
8 07	1	1513	18 3622

WATERGATE  
 HAVEN Report 1994

RUN  
 22 18

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CN

C

8	10-	1	1572-	15	7814-
6	06-		7168-	10	2757-
4	04-		3992-	6	0437-
2	02-		1574-	2	7588-
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	00		0279		3401
1	01		0399		7441
2	02		1574	2	5434
4	04		3553	5	6817
6	06		7048	10	0740
8	09	1	1049	14	9652
4	01-		0711-	1	8000-
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	01		1777	2	8287
1	01		0456		8000
2	02		1559	2	9107

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23A 19

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3	08-
6	07-
4	04-
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CN

7095-
6508-
3737-
1006-
1511-
0136
0567
1375
3517
8754
9562
5583-
1798-
0639-
0482-
547
0812-
1610-
0078-
3250
6131
3959-
3619-
2342-
2292-
0138-

C

8	3783-
7	6133-
4	6734-
1	6939-
1	6671-
	0242
	6835
1	8829
4	3683
6	8588
10	5369
6	6554-
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	1382-
	8532-
1	4112-
	4872-
1	4722-
	2923
4	1222
7	1222
4	5671-
4	6822-
2	9822-
2	9822-
	1179-

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22A 2C

8 53-  
 6 36-  
 4 23-  
 2 11-  
 1 06-  
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 6 36  
 8 54  
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7656-  
 4200-  
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 0616-  
 0043-  
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 4147  
 6525  
 0602-  
 0049-  
 0509  
 2516

H 8292-  
 5 7705-  
 3 6242-  
 1 7362-  
 9246-  
 0853-  
 1 6082  
 5 7222  
 2 6489  
 8094-  
 0841-  
 7506  
 3 5150

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22A 21

$\alpha$	CN	Co
4 51-	1 4567-	H 3400-
2 23-	6A09-	3 0000-
1 14-	373A-	2 2000-
01-	U134-	2 2000-
1 10	3343	1 7100
2 26	7490	4 2303
4 52	1 4940	0 5000
6 00	2 3020	14 3007
9 60	4 0017	27 1000
12 17	4 7713	34 7704
4 52-	1 4666-	0 4603-
2 25-	7161-	4 1100-
1 13-	3556-	2 1100-
01-	U130-	1 1101
1 14	3600	2 2007
8 10	2 0106	17 0003
9 50	3 4900	24 1000
10 90	4 2190	30 1000
6 90	2 3500	14 0000
4 00	2 3207	14 0000
4 56	1 5213	9 0000
2 27	7233	0 0000
02	0100	0 0000
3 33	2 7000	16 0000
3 34	3 3017	21 0000
10 77	4 0000	20 0000
2 25	1 4790	4 0000
2 25	7218	4 0000

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 MVED Report 1974

82A 82

	$\alpha$	CN	Co
4	45-	1 3405-	8 6742-
2	14-	5464-	3 4989-
1	10-	2980-	1 8477-
	01-	0255-	2 2678-
1	13	2723	8 4089
2	21	6467	3 9078
4	48	1 4893	9 1873
6	92	2 2029	15 3782
9	71	4 2860	32 0880
12	07	4 7318	38 5803
1	40-	1 0381-	7 4733-
	04	0928	7 4228
	90	3109-	1 9174-
	88-	3688	8 3884
4	43	1 3008	8 2078
9	33	3 2872	84 8784
8	64	1 8038	18 0038

228 23

α

4	32-
2	16-
1	10-
	04-
1	02
2	07
4	25
6	36
8	53
10	70
2	81-
1	11-
	09-
1	08
4	23
2	17-
	03-

CN

1	0708-
	9107-
	6662-
	2505-
	1435
	2111
1	4022
2	2029
3	2804
4	2976
1	1277-
	6347-
	4343-
	0807
1	3564
1	0833-
	2633-

CO

4	4141-
4	3341-
2	7868-
1	0834-
	4972
1	9813
6	3402
9	6237
13	9640
10	4094
5	6010-
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	3736-
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5	9807
4	5820-
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**WATERGATE**  
**INVESTIGATION REPORT 273A**

**32A 24**

<i>α</i>	CN	Co
4 41-	2 3784-	8 9008-
2 2 -	1 3040-	4 7755-
1 10-	8247-	3 0346-
05-	2808-	9925-
1 05	4113	0774
2 15	7250	2 7853
4 36	1 7349	6 6808
6 61	2 8906	11 3006
8 91	4 4232	17 1094
11 20	5 7429	22 4040
6 61	2 9206	11 4043
8 93	4 4705	17 3740
11 31	6 0036	24 3773